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(NASA-CR-147847) STAR TRACKER CONSTRAINT VIOLATIONS DIGITAL CAPABILITY DESCRIPTION AND ANALYSIS RESULTS. MISSION PLANNING, MISSION ANALYSIS, AND SOFTWARE FORMULATION (McDonnell-Douglas Technical Services) 32 p
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MCDONNELL DOUGLAS TECHNICAL SERVICES CO.
HOUSTON ASTRONAUTICS DIVISION

SPACE SHUTTLE ENGINEERING AND OPERATIONS SUPPORT

DESIGN NOTE NO. 1.4-2-7

STAR TRACKER CONSTRAINT VIOLATIONS DIGITAL CAPABILITY DESCRIPTION AND ANALYSIS RESULTS

MISSION PLANNING, MISSION ANALYSIS AND SOFTWARE FORMULATION

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1.0 SUMMARY

Results of star tracker constraint violation analyses performed with the digital computer program Shuttle Attitude and Pointing Time Line Processor (SAPT) are presented in this note. These analysis results are typical of those utilized to provide the information required to update Baseline Reference Mission Attitude and Pointing Time Lines. Descriptions of SAPT modifications implemented to perform these analyses are also presented.

2.0 INTRODUCTION

The purpose of this note is to present results of star tracker constraint violation analyses and to document and discuss the associated modifications to Program SAPT designed to detect star tracker constraint violations. This note, therefore, describes and documents a tool which may be utilized to analyze attitude and pointing time lines, now and in the future, for possible star tracker constraint violations. This capability has been utilized to perform initial analyses which are reflected in the time lines presented in References (1) and (2). This capability and other simulation requirements designed to support attitude profile analyses are discussed briefly in Reference (3).

3.0 DISCUSSION

The orbiter vehicle has three star trackers. Each is sensitive to bright light and cannot be operated within certain regions of the sun or sunlit earth. Attempting to operate any one of the star

trackers with its centerline Field of View (FOV) within 30 degrees of the sun or within 20 degrees of the sunlit earth horizon would violate operational constraints imposed on this instrument. Violations may occur while performing Inertial Measurement Unit (IMU) platform alinements or while tracking targets during normal Shuttle activities. This condition in certain cases can be avoided by selecting alternate orbiter attitudes, and a method to detect these violations can be useful in establishing a pre-mission attitude and pointing profile.

Consideration was given to developing a separate program to determine the constraint violations, but it was determined that Program SAPT would be the most convenient tool with which to perform the violation analyses. There are three main reasons why this is the case. First, Program SAPT generates the attitude and pointing time line profiles and contains all of the attitude related information required to establish the necessary attitude transformation relationships. Second, the program can be easily modified, and third, the program employs routines required for certain computations associated with the star tracker constraint violation model.

4.0 RESULTS

Figure 1 depicts the earth pointing constraint detection model implemented in Program SAPT. It assumes the earth is a sphere. Since the earth is assumed to be spherical, the angle, α, between the vehicle to earth-tangent line and vehicle to earth-center line will be constant if

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the vehicle's altitude remains constant, i.e., if the vehicle's orbit is circular. The earth pointing constraint is violated when the angle between the star tracker FOV centerline and the vehicle to earth centerline, Θ, decreases below the value of $\alpha + 20°$. This is equivalent to the star tracker centerline FOV entering the earth pointing constraint region and, therefore, violating the earth pointing constraint. The sun constraint detection model is implemented in a similar manner. The sun is regarded as a point source, and sun pointing constraints are violated when the star tracker centerline FOV enters within 30 degrees of the sun to vehicle line.

Program SAPT was modified to incorporate this model.

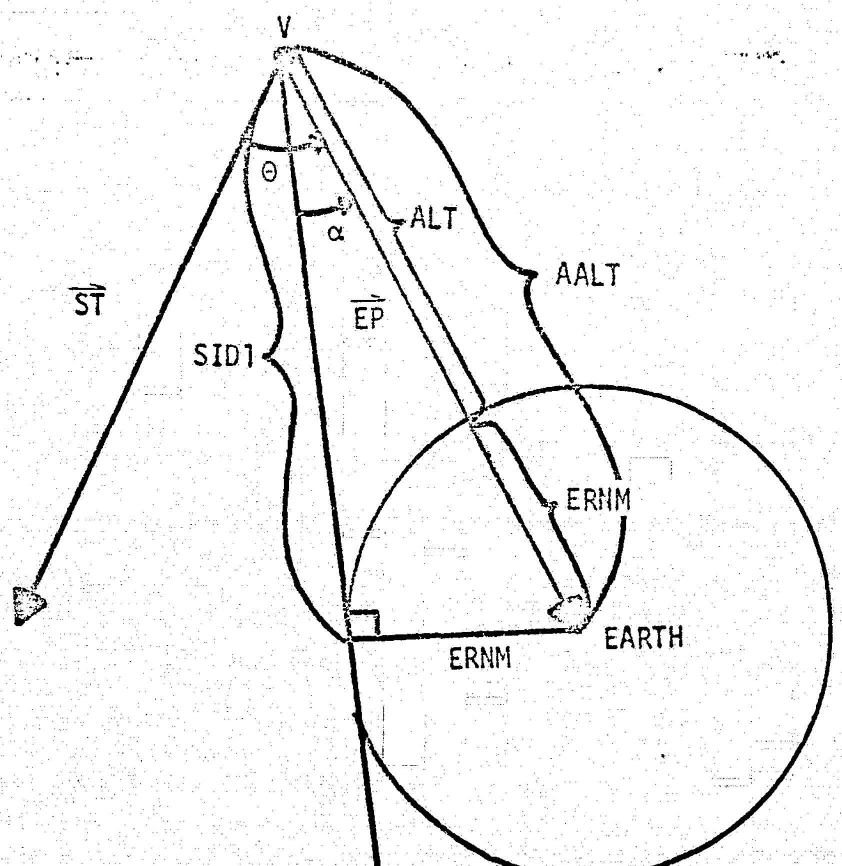

FIGURE 1: MODEL USED IN DETERMINING STAR TRACKER CONSTRAINT VIOLATION ANALYSIS LOGIC *

* All symbols used in model are defined in Appendix A.

The angle between the earth pointing vector in the body coordinate system (as defined in Reference (4)) and the line of sight to the horizon of the earth is computed using equation (1), where ERNM and SID1 are defined in Appendix A.

$$\alpha = \arctan \frac{ERNM}{SID1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

For purposes of testing earth pointing constraint violations, α is computed irrespective of lighting conditions of the earth, a consideration that will be given to a later, more sophisticated model. The angle for the testing of sun pointing constraint violations was set to a constant 30°, hence no α computations are required. Expressions to compute theta (Θ), the angle between the earth pointing or sun pointing vectors in the body coordinates, are given by equation (2) for earth pointing and equation (3) for sun pointing.

$$\Theta = \arccos \left[\frac{\vec{ST} \cdot \vec{EP}}{|\vec{ST}| \; |\vec{EP}|} \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\Theta = \arccos \left[\frac{\vec{ST} \cdot \vec{SP}}{|\vec{ST}| \; |\vec{SP}|} \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

All symbols used in computing Θ and α, including $\vec{ST}$, $\vec{EP}$ and $\vec{SP}$, are defined in Appendix A, and the basic figure for determining the math model used in program modifications is illustrated in Figure (1).

The star tracker pointing vector, $\vec{ST}$, for star trackers 1, 2, and 3 are computed by taking the transpose of the Body to Star Tracker coordinate transformation matrices obtained from Reference (5) for

each Star Tracker, and post multiplying each by the unit vector along the Z coordinate axis $\left(\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}\right)$. The earth pointing and sun pointing vectors used in equations(2) and (3) are computed by SAPT subroutine TARVEC in the earth centered, Aries Mean of 1950, inertial coordinate system described in Reference (4). The vectors are then transformed into the body coordinate system by a call from SAPT to subroutine BPCR (Body Pointing Conversion Routine). Once computed, the dot products of the star tracker pointing vectors and Earth or Sun pointing unit vectors for all pertinent pointing vectors are computed by subroutine UNVEC. Completing all preliminary computations, equations (2) and (3) are employed to compute Θ for each star tracker. Coding of Program SAPT is presented in Appendix B with all modifications indicated by the word "NEW" on the right hand side of the page.

The operation of this logic will be briefly described. A value of 20 degrees is added to the computed α for earth pointing in accordance with the constraints specified in Reference (5). Every Θ corresponding to the combinations of star trackers and earth and sun pointing vectors is then computed. Each Θ is compared against α (+ 20 degrees) for the earth and α (= 30 degrees) for the sun, testing for $\Theta < \alpha$ ($\alpha + 20°$ for the earth). If such tests are successful, i.e. $\Theta < \alpha$, a special code as defined in Reference (6) is output through modifications to SAPT output logic, indicating which constraint had been violated — Earth Pointing or Sun Pointing Constraints — and which Star Trackers are in violation of that

particular constraint. If the event being processed is not a platform alinement, computations and tests are not considered, and most computation logic is skipped.

Modifications for star tracker constraint violations analysis were used in the checkout of platform alinements being considered for certain inertial hold attitudes defined in the Preliminary Baseline Reference Mission (BRM) 2, Sortie Option 1 Attitude and Pointing Time Lines. Results indicated that nearly 90% of the alinements were performed with constraint violations, as illustrated in Reference (6). Sortie Options 2 and 3 of BRM 2 as well as BRM 1 showed similar results. Sortie Option 2 of BRM 2 is illustrated in Appendix C which shows that 8 out of 9 platform alinements violate star tracker pointing constraints when holding the prior inertial attitude.

Since extensive violations occurred in the inertial attitude just prior to a platform alinement, a maneuver to the LVLH attitude at 0,0,0 was then assumed, just prior to each Platform Alinement, and checkout attitude and pointing time lines were generated. Results showed no violations occurring for any Sortie Option of Mission 2, but due to the relatively low altitude for Mission 1, platform alinements performed in the inertial hold mode at an initial LVLH attitude of 0,0,0 always violated the earth pointing constraint for star tracker 3. (Appendix (D))

In updating BRM 1 and 2 time lines, the same violations were assumed

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to hold since new trajectories indicated no change in altitude. Checkout results indicated this to be the case. For updates to BRM 1, therefore, a slight Roll of +5° was employed to assume an LVLH attitude at 0,0,5, with checkout results indicating that the selected attitude was sufficient to prevent further violation of constraints. A study of results using Star Tracker constraint violation detection logic revealed that updated Preliminary BRM 1 and 2 could be generated with platform alinements in LVLH attitudes at 0,0,5 and 0,0,0 respectively without violating any Star Tracker constraints. Results of updated time line generation for BRM 1 and 2 are illustrated in References (1) and (2).

5.0 CONCLUSION

The analysis results presented in Appendices C and D of this note are typical of those performed on preliminary Baseline Reference Mission Attitude and Pointing Time Lines to insure that no star tracker near earth or near sun pointing constraints were violated during IMU platform alinements.

The documented description of Star Tracker constraint violation modifications to program SAPT and descriptions of results using these modifications, as presented in this note, initially provides an adequate source of information. Program SAPT can be used to efficiently detect Star Tracker constraint violations and employ possible methods to insure avoidance of these violations. It is planned to upgrade the model used to detect star tracker constraint violations to

include an ellipsoidal earth model, earth occultation,earth lighting, and vehicle attitude dispersions. Capabilities such as these, to analyse attitude profiles, will continue to be developed, and analyses utilizing these capabilities will be performed to refine attitude and pointing profiles based on known attitude and pointing related constraints.

6.0 REFERENCES

1. SSEOS 1.4-MIB-16, "Preliminary Baseline Reference Mission 1 Attitude and Pointing Time Lines", McDonnell Douglas Technical Services Company, Inc., dated 17 January 1975.
2. SSOES 1.4-MIB-12, "Preliminary Baseline Reference Mission 2 Attitude and Pointing Time Lines", McDonnell Douglas Technical Services Company, Inc., dated 8 January 1975.
3. SSEOS Design Note No. 1.4-2-6, "Attitude and Pointing Simulation Requirements and Program Updates", dated 24 December 1974.
4. JSC-09084, NASA TM X-58153, "Coordinate Systems for the Space Shuttle Program", dated October 1974.
5. SSEOS Design Note No. 1.4-2-4, "Orbiter Star Tracker Orientations, Operational Requirements and Coordinate Transformations", dated 24 October 1974.
6. SSEOS TM-1.4-MIB-9, "Detection of Star Tracker Constraint Violations", dated 16 December 1974.

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APPENDIX A: LIST OF SYMBOLS USED IN STAR TRACKER CONSTRAINT VIOLATION LOGIC

(1) V - Reference Vehicle

(2) ALT - Vehicle Altitude in Nautical Miles Referenced from Surface of the Earth - Computed in Subroutine NADIR and Returned to Program SAPT

(3) ERNM - Earth Radius Expresed in Nautical Miles - Placed into SAPT by use of the DATA Statement

(4) AALT - Total Distance from the Center to the Earth to the Reference Vehicle in Nautical Miles -
AALT = ALT + ERNM

(5) SID1 - Distance from Reference Vehicle to Tangent of Line of Sight to Horizon and the Earth in Nautical Miles -

$$SID1 = \sqrt{(AALT)^2 - (ERNM)^2}$$

(6) $\vec{EP}$ - Earth Pointing Vector Expressed in Body Coordinates

(7) $\vec{SP}$ - Sun Pointing Vector Expressed in Body Coordinates

(8) $\vec{ST}$ - Star Tracker Pointing Vectors for Star Trackers 1, 2, and 3, Expressed in Body Coordinates

(9) α - Angle Between Earth Pointing Vector and Line of Sight to the Horizon of the Earth Expressed in Degrees -
α = [ARCTAN (ERNM/SID1)] X 57.29577951

(10) Θ - Angle Between Earth Pointing Vector or Sun Pointing Vector and Star Tracker Pointing Vectors for each Star Tracker, Expressed in Body Coordinates -

$$\Theta_1 = \left[\text{ARCCOS}\left(\frac{\vec{ST} \cdot \vec{EP}}{|\vec{ST}|\ |\vec{EP}|}\right)\right] \times 57.29577951$$

$$\Theta_2 = \left[\text{ARCCOS}\left(\frac{\vec{ST} \cdot \vec{SP}}{|\vec{ST}|\ |\vec{SP}|}\right)\right] \times 57.29577951$$

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CODING OF PROGRAM SAPT WITHOUT SUBROUTINES

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00100    CDI              **** PROGRAM SAPT ****
00100    CDI   THE SHUTTLE ATTITUDE AND POINTING TIMELINE PROCESSOR (SAPT) IS THE
00100    CDI    BASIC ATTITUDE AND POINTING TIMELINE GENERATION PROGRAM FOR
00100    CDI    SHUTTLE. SAPT CAN GENERATE ATTITUDE AND POINTING TIMELINE TABLES
00100    CDI    FOR DOCUMENTATION AND AT THE SAME TIME ALSO GENERATE ATTITUDE
00100    CDI    TAPES FOR SUBSYSTEM EVALUATIONS. THE BASIC INPUT IS IN THE FORM
00100    CDI    OF ATTITUDE AND POINTING DESCRIPTOR CARDS DEFINING THE NAME OF
00100    CDI    THE EVENT, THE EVENT TIME, AND DESCRIPTORS DEFINING THE ATTITUDE
00100    CDI    AND POINTING REQUIREMENTS FOR THE EVENT. THE PROGRAM REQUIRES
00100    CDI    A TRAJECTORY TAPE MOUNTED ON UNIT F, AN EPHEMERIS TAPE MOUNTED ON
00100    CDI    UNIT K, AND A PCF TAPE INCLUDING SAPT. IF AN ATTITUDE TAPE IS ALSO
00100    CDI    TO BE GENERATED, A SAVE TAPE MUST BE MOUNTED ON THE TAPE UNIT
00100    CDI    DEFINED BY ITAPE. THE FIRST INPUT CARD AFTER THE XQT CARD MUST BE
00100    CDI    A BASE CARD GIVING THE BASE DATE TO MEASURE G.E.T. FROM AND THE
00100    CDI    TAPE UNIT AND PRINT INTERVAL IF A ATTITUDE TAPE IS TO BE GENERATED
00100    CDI    THERE IS ALSO AN INPUT FLAG WHICH DEFINES A TAPE UNIT TO WRITE A
00100    CDI    DESCRIPTOR TIMELINE. AFTER THE BASE CARD, THE ATTITUDE AND POINT-
00100    CDI    ING DESCRIPTOR CARDS FOLLOW. THERE MAY BE UP TO 4 CARDS REQUIRED
00100    CDI    TO DEFINE EACH EVENT. THE FIRST CARD IN EACH EVENT SET IS THE
00100    CDI    EVENT NAME CARD. UP TO 4 LINES OF EVENT DESCRIPTION CAN BE DEFINED
00100    CDI    WITH 18 CHARACTERS TO EACH LINE. THE NEXT CARD IS THE ATTITUDE
00100    CDI    REQUIREMENTS CARD GIVING THE EVENT TIME AND ATTITUDE ONLY REQUIR-
00100    CDI    MENTS. IF THERE ARE NO POINTING REQUIREMENTS, THIS IS THE LAST
00100    CDI    CARD OF THE SET. IF THERE ARE POINTING REQUIREMENTS, 1 OR 2 MORE
```

```
00100   CD1   CARDS ARE REQUIRED DEPENDING ON THE NUMBER OF POINTING REQUIRE-
00100   CD1   MENTS. EVENT SETS SHOULD BE STACKED IN CHRONOLOGICAL ORDER. THE
00100   CD1   LAST CARD OF THE DECK IS LABELED 'END CARD' STARTING IN CC 1.
00100   CD1   THE INPUT PARAMETER DEFINITIONS FOR THE BASE CARD ARE GIVEN BELOW.
00100   CD1   THE INPUT DEFINITIONS FOR THE EVENT SETS ARE GIVEN IN SUBROUTINE
00100   CD1   'CARDIN'
00100   CD2  BASE CARD DEFINITIONS -
00100   CD2   NBASYR,NBASMT,NBASDY,NBASHR,NBASMN,BASSEC
00100   CD2           - BASE G.M.T. THAT G.E.T. IS MEASURED FROM (NOMINALLY THE
00100   CD2             LAUNCH G.M.T.
00100   CD2   ITAPE   - UNIT ON WHICH THE COMMON FORMAT ATTITUDE TAPE IS TO BE
00100   CD2             WRITTEN. IF ZERO, NO TAPE IS REQUIRED.
00100   CD2   GMTINT  - TIME INCREMENT BETWEEN PRINT POINTS DESIRED FOR THE
00100   CD2             COMMON FORMAT TAPE. (MINUTES)
00100   CD2   IUREAD  - UNIT ON WHICH THE INPUT ATTITUDE DESCRIPTOR FILE WILL BE
00100   CD2             MOUNTED. IF ZERO, ALL INPUT WILL BE MANUAL.
00100   CD2   IUWRT   - UNIT ON WHICH THE REVISED ATTITUDE DESCRIPTOR FILE IS TO
00100   CD2             BE WRITTEN. IF ZERO, NO TAPE IS TO BE WRITTEN.
00100   CD2   IHRST,MINST,SECST
00100   CD2           - GET TO START ATTITUDE TIMELINE IF A DESCRIPTOR FILE HAS
00100   CD2             BEEN PROVIDED. IF NOT INPUT, THE START OF THE DESCRIPTOR
00100   CD2             FILE, OR THE FIRST MANUAL INPUT, WHICHEVER IS EARLIER,
00100   CD2             WILL BE USED.
00100   CD2   IHREND,MINEND,SECEND
00100   CD2           - GET TO END ATTITUDE TIMELINE IF A DESCRIPTOR FILE HAS
00100   CD2             BEEN PROVIDED. IF NOT INPUT, THE END OF THE DESCRIPTOR
00100   CD2             FILE, OR THE LAST MANUAL INPUT, WHICHEVER IS LATER,
00100   CD2             WILL BE USED.
00100   C
00101         INTEGER ATTSYS,ALIGN
00103         REAL IANG1,IANG2,IANG12,IANG22
00104         DOUBLE PRECISION BASEJD,BASTIM,TGET,GMT,GMTP
00105         DOUBLE PRECISION GMTNXT,TSMCAL,TNEXT,TIMTAP
00106         DOUBLE PRECISION XIMUDP,YIMUDP,ZIMUDP,RKMDP(3),VKMDP(3),DV(3)
00107         DOUBLE PRECISION GET
00110         DOUBLE PRECISION RSUNDP(3)
00111         REAL LIFTKG,ISPSEC
00112         REAL KX,KY,KZ,NUZ,MINTIM
00113         DIMENSION DUMMAT(15),R(3),V(3),RSUN(3),VSUN(3),RMOON(3),VMOON(3)
00114         DIMENSION TARGET(3),TDVEC(3),ATTLV(3,3),ATTI(3,3),SUNVEC(3),
00114        * PB(3),COEVEC(3),ATTECI(3,3)
00115         DIMENSION RKM(3),VKM(3),RKMU(3),RSUNU(3)
00116         DIMENSION ATTSR(3,3)
00117         DIMENSION SPARE(14),RSUNKM(3)
00120         DIMENSION ST12(3),ST3(3),SOSO(3),HOMO(3)                         *NEW*
00121         DIMENSION SMAG1(3),SMAG2(3),SMAG3(3),SMAG4(3)                    *NEW*
00122         COMMON/BASDT/ BASEJD,BASTIM,NBASYR,NBASMT,NBASDY,NBASHR,NBASMN,
00122        * BASSEC
00123         COMMON/ATPCOM/ GMTP,ATTP(3,3)
00124         COMMON/IERRCM/ IERR
00125         COMMON / VEHLB / KX,KY,KZ,NUZ,BETA,RASUN,DECSUN,RAMOON,DECMON
00126         COMMON/SMCALL/ TSMCAL,RSUN,VSUN,RMOON,VMOON
00127         COMMON/CARDS/IHR,MN,SECS,ATTSYS,IMUNUM,IVMS,ANG1,ANG2,ANG3,
00127        * IHOLD,XRATE,YRATE,ZRATE,IPTFLG,ALIGN,INSTID,IANG1,IANG2,
00127        * ITYPE1,IDEF1,VAR1,VAR2,VAR3,ITARG1,VAR4,IDIN2,IANG12,IANG22,
00127        * ITYPE2,IDEF2,VAR12,VAR22,VAR32,ITARG2,VAR42
00130         COMMON/TVCOM/ ITARG,ALPHAT,BETAT,WVEC(3),ALPHAC,BETAC,AT,
00130        * TLON,TLAT,ITYPE,IDEF
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00131         COMMON/EVNCOM/NEVENT(12),NAMTAR
00132         COMMON / REVST / REV
00132   C     REV = REV NUMBER OF VEHICLE FROM START OF MISSION
00133         COMMON /TRJCNV /A,E,DINC,ARGPER,ASCNOD,AM,OMEAN,TRUEAN,PERIOD
00134         DATA RTD/57.2957795/,SECPHR/3600.0/
00137         DATA DUMMAT / 15 * 0.0 /,MINTIM / -1.0 /
00142         DATA ITAPE / 15 /
00144         DATA NBLANK/6H      /,MAXLIN/56/,NUMLIN/56/
00150         DATA NCARD / 6H      /
00150   C     EGRAVC - GRAVITATIONAL CONSTANT OF THE EARTH ( KM**3 / SEC**2 )
00152         DATA EGRAVC / 398.60119999 /
00152   C     DV - SENSED VELOCITY CHANGE OVER TIME INTERVAL BETWEEN PRESENT
00152   C          AND PREVIOUS RECORD
00154         DATA DV / 0.000,0.000,0.000  /
00156         DATA SPARE / 14 * 0.0 /
00160         DATA NUMENT/1/
00160   C                                                                       *NEW
00160   C-----STORE VALUES FOR STAR TRACKER POINTING VECTORS                    *NEW
00160   C      IN BODY COORDINATES, ANGLE ALPHA FOR SUN POINTING                *NEW
00160   C      CONSTRAINTS,EARTH RADIUS IN NAUTICAL MILES,                      *NEW
00160   C      AND CODES FOR VIOLATION OUTPUT------                             *NEW
00160   C                                                                       *NEW
00162         DATA ST12/0.0,0.0,-1.0/,ST3/-.25881904,-.96592583,0.0/            *NEW
00165         DATA SALPHA/30.0/                                                 *NEW
00167         DATA ERNM/3443.931/                                               *NEW
00171         DATA IA/1HA/,IB/1HB/,IC/1HC/,ID/1HD/,IE/1HE/,IQ/1H /,IG/1HG/,     *NEW
00171        *IH/1HH/,INAME/6HPLATFO/                                           *NEW
00203         PRTFLG = 0.0
00204         LIFTKG = 0.0
00205         DYNPR = 0.0
00206         DRAGKG = 0.0
00207         WGTKG = 0.0
00210         THRKG = 0.0
00211         ISPSEC = 0.0
00212         CALL INTMSG(0,0,0)                                                *NEW
00212   C  BASE CARD VALUES AND FORMAT FOLLOW                                   ***1
00212   C
00213         READ(5,910) NBASYR,NBASMT,NBASDY,NBASHR,NBASMN,BASSEC,
00213        * ITAPE,GMTINT,IUREAD,IUWRT,IHRST,MINST,SECST,IHREND,MINEND,SECEND
00213        *,IASTP
00236     910 FORMAT(1X,I4,4(1X,I2),1X,F5.2,1X,I2,1X,F6.0,2(1X,I2),
00236        *  2(1X,I4,1X,I2,1X,F5.2),12X,I1)
00236   C
00237         WRITE(6,900)
00241     900 FORMAT(1H1)
00242         CALL DATEC
00243         GETST = IHRST + MINST/60.0  + SECST/3600.0
00244         GETEND = IHREND + MINEND/60.0 + SECEND/3600.0
00245         IF(GETEND .LE. GETST) GETEND = 200.0
00247         CALL INPROC(IUREAD,GETST,GETEND,NUMENT)
00250     100 CONTINUE
00250   C  THE CALL TO GETDES OBTAINS THE FIRST EVENT SET
00250   C
00251         CALL GETDES(IUREAD,ISTOP)
00251   C
00252         CALL CRDFIL(1)
00253         IF(ISTOP .GT. 0) GO TO 350
00255         IF(IERR .GT. 0) STOP
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00257     120 CONTINUE
00260         JPCARD = 1
00261         TGET = IHR + MN/60 + SECS/3600
00262         GMT = TGET + BASTIM
00263     150 CONTINUE
00264         CALL TIMEC(GMT,IDAYN,IHRN,MINN,SECN)
00265         TIMTAP = GMT - BASTIM
00266         CALL TIMEC (TIMTAP,IDT,IHT,IMT,ST)
00267         IHT = IDT*24 + IHT
00270         TTAPE = SNGL(TIMTAP)
00271         IF(IHRN .GT. 2) .AND. (IDAYN - IDCALL) .EQ. 1) IDCALL = IDCALL-1
00273         IF((IDAYN - IDCALL) .GE. 0 .AND. (IDAYN - IDCALL) .LT.2) GO TO 200
00275         IDCALL = IDAYN
00276         IF(IHRN .LT. 2) IDCALL = IDAYN - 1
00300         CALL INITAL(IDCALL,ISTOP)
00301         IF(ISTOP .GT. 0) STOP
00303     200 CONTINUE
00304         IF(ALIGN .NE. 1) GO TO 220
00306         CALL CRDFIL(2)
00307         CALL ATTDEF(GMT,ATTP)
00310         GMTP = GMT
00311         CALL CRDFIL(1)
00312     220 CONTINUE
00313         IF (ATTSYS .EQ. NBLANK) IBLANK = 1
00315         IF(ATTSYS .EQ. NBLANK) CALL CRDFIL(2)
00317         CALL ATTDEF(GMT,ATTECI)
00320         CALL CRDFIL(1)
00321         IF(ATTSYS .NE. NBLANK) GO TO 225
00323         DO 223 I=1,3
00326         DO 223 J=1,3
00331         ATTI(I,J) = ATTECI(I,J)
00332     223 CONTINUE
00335         CALL EULER(ATTI,IVMS,ANG1,ANG2,ANG3,ATTECI)
00336     225 CONTINUE
00337         CALL NADIR(GMT,SCLON,GDLAT,ALT)                                  *NEW
00337   C                                                                      *NEW
00337   C-----COMPUTE ANGLE  ALPHA(ANGLE BETWEEN VEHICLE TO COE VECTOR AND      *NEW
00337   C     STAR TRACKER POINTING VECTOR) FOR EARTH POINTING CONSTRAINTS,     *NEW
00337   C     AND ADD 20 DEGREES TO ALPHA TO COMPUTE FINAL ALPHA FOR            *NEW
00337   C     STAR TRACKER EARTH POINTING CONSTRAINT VIOLATIONS CHECKOUT------- *NEW
00337   C                                                                      *NEW
00340         AALT=ERNM+ALT                                                    *NEW
00341         TRIA1=(AALT**2)-(ERNM**2)                                        *NEW
00342         SID1=SQRT(TRIA1)                                                 *NEW
00343         EALPHA=ATAN2(ERNM,SID1)                                          *NEW
00344         EALPHA=EALPHA*RTD                                                *NEW
00345         EALPHA=EALPHA+20.0                                               *NEW
00346         WRITE(6,137)EALPHA                                               *NEW
00351   137   FORMAT(1X,F10.5)                                                 *NEW
00352         IF(IPTFLG .EQ. 0) GO TO 250
00354         CALL FILTVC(1)
00355         IF(ATTSYS.EQ.NBLANK) CALL CRDFIL(2)
00357         CALL TARVEC(GMT,NEWVEL,TARGET,TDVEC)
00360         CALL BPCR(1,ATTECI,TARGET,PB)
00361         CALL YWPTCH(2,YAWTAR,PTCTAR,PB)
00362     250 CONTINUE
00363         ITYPE =1
00364         IDEF = 8
```

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00365          CALL TARVEC(GMT,NEWVEL,SUNVEC,TDVEC)
00366          CALL BPCR(1,ATTECI,SUNVEC,PB)
00366    C                                                              *NEW
00366    C-----SAVE SUN POINTING VECTOR IN BODY COORDINATES------       *NEW
00366    C                                                              *NEW
00367          DO19I=1,3                                                *NEW
00372          SOSO(I)=PB(I)                                            *NEW
00373       19 CONTINUE                                                 *NEW
00375          CALL YWPTCH(2,YAWSUN,PTCSUN,PB)
00376          ITYPE = 1
00377          IDEF = 1
00400          CALL TARVEC(GMT,NEWVEL,COEVEC,TDVEC)
00401          CALL BPCR(1,ATTECI,COEVEC,PB)
00401    C                                                              *NEW
00401    C-----SAVE EARTH POINTING VECTOR IN BODY COORDINATES FOR LATER USE-----  *NEW
00401    C                                                              *NEW
00402          DO13J=1,3                                                *NEW
00405          HOMO(J)=PB(J)                                            *NEW
00406       13 CONTINUE                                                 *NEW
00410          CALL YWPTCH(2,YAWCOE,PTCCOE,PB)
00411          CALL ACP(1,2,2,4,1,3,3,IMUNUM,IMUNUM,GMT,GMT,ATTECI,TDVEC,
00411         * OMG,0.0,0.0,0.0,YRATE,ZRATE,XRATE,ATTLV,YOFF,ZOFF,XOFF)
00412          ZLVLH = ZOFF*RTD
00413          YLVLH = YOFF*RTD
00414          XLVLH = XOFF*RTD
00415          IF(ZLVLH .LT. -0.05) ZLVLH = 360.0 + ZLVLH
00417          IF(YLVLH .LT. -0.05) YLVLH = 360.0 + YLVLH
00421          IF(XLVLH .LT. -0.05) XLVLH = 360.0 + XLVLH
00423          IF(IHOLD .NE. 1) GO TO 260
00425          CALL ZLVDOT(7,XLVLH,YLVLH,ZLVLH,XRATE,YRATE,ZRATE)
00426          XRATE = XRATE*(SECPHR/RTD)
00427          YRATE = YRATE*(SECPHR/RTD)
00430          ZRATE = ZRATE*(SECPHR/RTD)
00431      260 CONTINUE
00432          IF(IMUNUM .EQ. 0) IMUNUM=1
00434          M=3
00435          IF(IASTP.EQ.1) M=2
00437          CALL ACP(1,2,2,4,3,3,M,IMUNUM,IMUNUM,GMT,GMT,ATTECI,TDVEC,
00437         * OMG,0.0,0.0,0.0,YRATE,ZRATE,XRATE,ATTI,YOFF,ZOFF,XOFF)
00440          ZIMU = ZOFF*RTD
00441          YIMU = YOFF*RTD
00442          XIMU = XOFF*RTD
00443          IF(ZIMU .LT. -0.05) ZIMU = 360.0 + ZIMU
00445          IF(YIMU .LT. -0.05) YIMU = 360.0 + YIMU
00447          IF(XIMU .LT. -0.05) XIMU = 360.0 + XIMU
00451          YAWTAR = YAWTAR*RTD
00452          PTCTAR = PTCTAR*RTD
00453          YAWSUN = YAWSUN*RTD
00454          PTCSUN = PTCSUN*RTD
00455          YAWCOE = YAWCOE*RTD
00456          PTCCOE = PTCCOE*RTD
00457          IF(SCLON .GT. 180.0) SCLON = SCLON - 360.0
00461          NUMCOM = 1
00462          DO 280 I=2,4
00465          DO 280 J=1,3
00470          IJ =(I-1)*3 + J
00471          IF(NEVENT(IJ) .NE. NBLANK) NUMCOM = I
00473      280 CONTINUE
```

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```
00476           CALL TRAJC1 (GMT,R,V,JERR)
00477           IF (JERR .GT. 0) STOP
00501           RMAG = VECMG(R)
00502           IF (ITAPE .EQ. 0) GO TO 288
00504           RECFLG = 1.0
00504     C     RECFLG- LAST RECORD IN FILE FLAG, IF LESS THAN 0.0 THIS IMPLIES
00504     C             LAST RECORD IN FILE
00504     C     PRTFLG- FLAG INDICATING TYPE OF PRINT POINT
00505           CALL GMTCAL (GMT,NBASYR,YEAR,GMONTH,GDAY,GHR,GMIN,GSEC )
00505     C     SUBROUTINE GMTCAL WILL COMPUTE GREENWICH MEAN TIME IN YEAR,
00505     C     MONTH,DAY,HOUR,MINUTES, AND SECONDS FROM THE BEGINNING OF THE
00505     C     BASE YEAR (NBASYR).
00506           GET = GMT - BASTIM
00506     C     GET - TIME IN HOURS FROM LAUNCH
00507           DO 281 J=1,3
00512           RKM(J) = R(J) * 6378.16
00512     C     RKM - VEHICLE RADIUS VECTOR (ECI) IN KM
00513           VKM(J) = V(J) * (6378.16 / 3600.0 )
00513     C     VKM - VEHICLE VELOCITY VECTOR (ECI) IN KM/SEC
00514           RSUNDP(J) = DBLE(RSUN(J)) * 6378.16D00
00515           RSUNKM(J) = SNGL(RSUNDP(J) )
00515     C     RSUNKM - SUN VECTOR IN KM (ECI)
00516       281 CONTINUE
00520           DO 285 I=1,3
00523           RKMDP(I) = DBLE (RKM(I) )
00523     C     RKMDP -  VEHICLE RADIUS VECTOR (DOUBLE PRECISION )
00524           VKMDP(I) = DBLE (VKM(I) )
00524     C     VKMDP -  VEHICLE VELOCITY VECTOR (DOUBLE PRECISION)
00525       285 CONTINUE
00527           XIMUDP = DBLE (XIMU) / 57.2957795D0
00530           YIMUDP = DBLE (YIMU) / 57.2957795D0
00531           ZIMUDP = DBLE (ZIMU) / 57.2957795D0
00531     C     YIMUDP,ZIMUDP,XIMUDP- PITCH, YAW, AND ROLL GIMBAL ANGLES (RADIANS)
00531     C                           WITH RESPECT TO INPUT REFSMMAT
00532           RMAGKM = VECMG (RKM)
00532     C     RMAGKM - VEHICLE GEOCENTRIC RADIUS (KM)
00533           CALL UNVEC (RKM,RKMU)
00533     C     RKMU - VEHICLE UNIT  RADIUS  VECTOR (ECI)
00534           DECGCN = ASIN  (RKMU(3))
00534     C     DECGCN - VEHICLE GEOCENTRIC DECLINATION (RADIANS)
00535           RASGCN = ATAN2 (RKMU(2),RKMU(1) )
00535     C     RASGCN - VEHICLE GEOCENTRIC RIGHT ASCENSION (RADIANS)
00536           VMAGKM = VECMG(VKM)
00536     C     VMAGKM - VEHICLE INERTIAL VELOCITY VECTOR MAGNITUDE (KM/SEC)
00537           VALTKM = ALT * (6378.16 / 3443.9308855)
00537     C     VALTKM - VEHICLE ALTITUDE ABOVE OBLATE EARTH (KM)
00540           VEHGDL = GDLAT / RTD
00540     C     VEHGDL - VEHICLE GEODETIC LATITUDE (RADIANS)
00541           VEHLON = SCLON / RTD
00541     C     VEHLON - VEHICLE LONGITUDE (RADIANS)
00542           CALL FPAZ  (GMT,GAMI,PSII,VELREL,GAMREL,PSIREL,GRAS )
00542     C     GAMI - INERTIAL FLIGHT PATH ANGLE (RADIANS)
00542     C     PSII - INERTIAL AZIMUTH (RADIANS)
00542     C     VELREL - RELATIVE VELOCITY VECTOR MAGNITUDE (KM/SEC)
00542     C     GAMREL - RELATIVE FLIGHT PATH ANGLE (RADIANS)
00542     C     PSIREL - RELATIVE AZIMUTH (RADIANS)
00542     C     GRAS - RIGHT ASCENSION OF GREENWICH (RADIANS)
00543           AKM = A * ( 1.0 / 3280.833 )
```

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```
00543          C       AKM - SEMIMAJOR AXIS (KM)
00543          C       E - ECCENTRICITY
00544                  RADINC = DINC / RTD
00544          C       RADINC - INCLINATION TO ORBITAL PLANE (RADIANS)
00545                  ASCNR = ASCNOD / RTD
00545          C       ASCNR - RIGHT ASCENSION OF ASCENDING NODE (RADIANS)
00546                  ARGPR = ARGPER / RTD
00546          C       ARGPR - ARGUMENT OF PERIGEE (RADIANS)
00546          C       TRUEAN - TRUE ANOMALY (RADIANS)
00546          C       PERIOD - ORBITAL PERIOD (SECONDS)
00546          C       SHADOW = 1.0  VEHICLE IN DIRECT SUNLIGHT
00546          C              =-1.0  VEHICLE IN DARKNESS
00547                  SHADOW = 1.0
00550                  CALL UNVEC (RSUN,RSUNU)
00551                  COSANG = DOT (RKMU,RSUNU)
00552                  IF ( ABS(COSANG) .GE. 1.0) COSANG = SIGN (1.0,COSANG)
00554                  IF ( ACOS(COSANG) .GE. ( 180.0 - ASIN(1.0/ RMAG)) ) SHADOW = -1.0
00554          C       ATTECI - DIRECTION COSINES OF THE X,Y, AND Z BODY AXES WITH
00554          C                RESPECT TO THE ECI COORDINATE SYSTEM
00556                  CALL ACP (1,2,2,4,5,3,3,IMUNUM,IMUNUM,GHT,GMT,ATTECI,TDVEC,
00556                 * OMG,0.0,0.0,0.0,0.0,0.0,0.0,ATTSR,ALSR,BTSR,GMSR )
00556          C       ALSR - PITCH FROM SOLAR REFERENCE SYSTEM (ZYX EULER)
00556          C       BTSR - YAW FROM SOLAR REFERENCE SYSTEM (ZYX EULER)
00556          C       GMSR - ROLL FROM SOLAR REFERENCE SYSTEM (ZYX EULER)
00557                  YLVLHR = YLVLH / RTD
00557          C       YLVLHR - VEHICLE PITCH ANGLE FROM LOCAL VERTICAL IN RADIANS.
00557          C                (ZYX EULER) YAW-PITCH SEQUENCE
00560                  ZLVLHR = ZLVLH / RTD
00560          C       ZLVLHR - VEHICLE  YAW  ANGLE FROM LOCAL VERTICAL IN RADIANS.
00560          C                (ZYX EULER) YAW-PITCH SEQUENCE
00561                  XLVLHR = XLVLH / RTD
00561          C       XLVLHR - VEHICLE  ROLL ANGLE FROM LOCAL VERTICAL IN RADIANS.
00561          C                (ZYX EULER) YAW-PITCH SEQUENCE
00562                  PTSUNR = PTCSUN / RTD
00562          C       PTSUNR - LOOK ANGLE THETA FROM VEHICLE TO SUN (YAW-PITCH SEQUENCE)
00563                  YWSUNR = YAWSUN / RTD
00563          C       YWSUNR - LOOK ANGLE PHI FROM VEHICLE TO SUN (YAW-PITCH SEQUENCE)
00564                  PTCOER = PTCCOE / RTD
00564          C       PTCOER - LOOK ANGLE THETA FROM VEHICLE TO CENTER OF EARTH.
00565                  YWCOER = YAWCOE / RTD
00565          C       YWCOER - LOOK ANGLE PHI FROM VEHICLE TO CENTER OF EARTH.
00565          C       SPARE - MATRIX FOR SPARE WORDS TO BE RESERVED FOR FUTURE USE
00565          C
00565          C    THE ATTITUDE TAPE RECORDS ARE WRITTEN BELOW
00565          C
00566                  WRITE (ITAPE)                     RECFLG,PRTFLG,YEAR,GMONTH,GDAY,
00566                 *GHR,GMIN,GSEC,GET,(RKMDP(I),I=1,3),(VKMDP(I),I=1,3),(DV(I),I=1,3),
00566                 * YIMUDP,ZIMUDP,XIMUDP,RMAGKM,DECGCN,RASGCN,VMAGKM,GAMI,PSII,
00566                 * VALTKM,VEHGDL,VEHLON,VELREL,GAMREL,PSIREL,GRAS,REV,AKM,E,RADINC,
00566                 * ASCNR,ARGPR,TRUEAN,PERIOD,DYNPR,DRAGKG,LIFTKG,WGTKG,THRKG,ISPSEC,
00566                 * EGRAVC,SHADOW,(ATTECI(1,J),J=1,3),(ATTECI(2,J),J=1,3),
00566                 * (ATTECI(3,J),J=1,3),YLVLHR,ZLVLHR,XLVLHR,ALSR,BTSR,GMSR,PTSUNR,
00566                 * YWSUNR,PTCOER,YWCOER,(RSUNKM(I),I=1,3),(SPARE(I),I=1,14)
00713             288 CONTINUE
00713          C
00714                  IF (JPCARD .EQ. 1) GO TO 290
00716                  NUMCOM = 1
00717             290 CONTINUE
```

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00720          IF(INUMLIN + NUMCOM) .LE. MAXLIN) GO TO 300
00722          WRITE(6,950)
00724      950 FORMAT(1H1,43X,'SHUTTLE ATTITUDE AND POINTING TIME LINE'//
00724         * 90X,'LOOK ANGLES   LOOK ANGLES   LOOK ANGLES'/
00724         * 34X,'VEHICLE POSITION    LVLH ATTITUDE',7X,'ECI ATTITUDE',6X,
00724         * 'TO SUN',6X,'TO EARTH',8X,'TO TARGET'/5X,'GET',
00724         * 25X,'ALT',3X,'LAT',4X,'LON',4X,'YAW  PITCH  ROLL   YAW  PITCH  ',
00724         * 'ROLL   YAW  PITCH   YAW  PITCH  TARG  YAW  PITCH'/
00724         * 1X,'HRS MN SECS',7X,'EVENT',9X,'N MI  DEG',4X,'DEG    DEG   DEG',
00724         * 3X,'DEG    DEG   DEG    DEG    DEG   DEG    DEG    DEG    ID',
00724         * 3X,'DEG   DEG'/)
00725          NUMLIN = 7
00726      300 CONTINUE
00726    C  THE ATTITUDE AND POINTING TABLE IS WRITTEN BELOW.
00726    C
00726    C                                                                  •NEW
00726    C-----COMPUTE ANGLE THETA BETWEEN STAR TRACKER POINTING VECTORS FOR  •NEW
00726    C     STAR TRACKERS 1,2, AND 3                                     •NEW
00726    C     AND SUN AND EARTH POINTING VECTORS, CHECK FOR EACH THETA     •NEW
00726    C     LESS THAN ALPHA=30 DEGREES FOR SUN, AND THETA LESS           •NEW
00726    C     THAN EARTH ALPHA + 20 DEG. FOR EARTH, AND OUTPUT             •NEW
00726    C     ANY VIOLATION ENCOUNTERED ACCORDING TO SPECIAL CODE          •NEW
00726    C     IF EVENT IS NOT PLATFORM ALINEMENT, THEN COMPUTATIONS        •NEW
00726    C     ARE NOT NECESSARY, AND LOGIC IS SKIPPED------                •NEW
00726    C                                                                  •NEW
00727          IF(NEVENT(1).NE.INAME) GO TO 3179                            •NEW
00731          CALL UNVEC(ST12,SMAG1)                                       •NEW
00732          CALL UNVEC(ST3,SMAG2)                                        •NEW
00733          CALL UNVEC(SOSO,SMAG3)                                       •NEW
00734          CALL UNVEC(HOMO,SMAG4)                                       •NEW
00735          DOTP1=DOT(SMAG1,SMAG3)                                       •NEW
00736          DOTP2=DOT(SMAG2,SMAG3)                                       •NEW
00737          DOTP3=DOT(SMAG1,SMAG4)                                       •NEW
00740          DOTP4=DOT(SMAG2,SMAG4)                                       •NEW
00741          ATHET1=ACOS(DOTP1)                                           •NEW
00742          ATHET1=ATHET1*RTD                                            •NEW
00743          ATHET2=ACOS(DOTP2)                                           •NEW
00744          ATHET2=ATHET2*RTD                                            •NEW
00745          ATHET3=ACOS(DOTP3)                                           •NEW
00746          ATHET3=ATHET3*RTD                                            •NEW
00747          ATHET4=ACOS(DOTP4)                                           •NEW
00750          ATHET4=ATHET4*RTD                                            •NEW
00751          IZ=IQ                                                        •NEW
00752          IF(ATHET1.LT.SALPHA.AND.ATHET4.LT.EALPHA) GO TO 23           •NEW
00754          IF(ATHET1.LT.SALPHA) IZ=IA                                   •NEW
00756          IF(ATHET4.LT.EALPHA) IZ=IB                                   •NEW
00760          GO TO 24                                                     •NEW
00761       23 IZ=IH                                                        •NEW
00762          GO TO 28                                                     •NEW
00763       24 IF(ATHET3.LT.EALPHA.AND.ATHET2.LT.SALPHA) GO TO 25           •NEW
00765          IF(ATHET3.LT.EALPHA) IZ=IC                                   •NEW
00767          IF(ATHET2.LT.SALPHA) IZ=ID                                   •NEW
00771          GO TO 26                                                     •NEW
00772       25 IZ=IG                                                        •NEW
00773       26 IF(ATHET3.LT.EALPHA.AND.ATHET4.LT.EALPHA) GO TO 27           •NEW
00775          GO TO 28                                                     •NEW
00776       27 IZ=IE                                                        •NEW
00777       28 CONTINUE                                                     •NEW
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```
      GO TO 9160                                                        •NEW
 3179 IZ=IQ                                                             •NEW
 9168 CONTINUE                                                          •NEW
      IF (JPCARD .EQ. 0) GO TO 305
      IF(ABS(ZLVLH).LT.0.0495) ZLVLH=.0                                 •NEW
      IF(ABS(YLVLH).LT.0.0495) YLVLH=.0                                 •NEW
      IF(ABS(XLVLH).LT.0.0495) XLVLH=.0                                 •NEW
      IF(ABS(ZIMU).LT.0.0495) ZIMU=.0                                   •NEW
      IF(ABS(YIMU).LT.0.0495) YIMU=.0                                   •NEW
      IF(ABS(XIMU).LT.0.0495) XIMU=.0                                   •NEW
      IF(ZLVLH.GT.359.9495) ZLVLH=.0                                    •NEW
      IF(ZIMU.GT.359.9495) ZIMU=.0                                      •NEW
      IF(IPTFLG .EQ. 0) WRITE(6,960) IHT,IMT,ST,(NEVENT(J),J=1,3),
     • ALT,GDLAT,SCLON,ZLVLH,YLVLH,XLVLH,ZIMU,YIMU,XIMU,YAWSUN,
C                                                                       •NEW
C-----OUTPUT FORMATS ARE ALTERED TO ACCEPT SPECIAL                      •NEW
C     STAR TRACKER CONSTRAINT VIOLATION CODE------                      •NEW
C                                                                       •NEW
     •PTCSUN,YAWCOE,PTCCOE,IZ                                           •NEW
  960 FORMAT(1X,I3,1X,I2,1X,F4.1,1X,3(A6),2(1X,F5.1),1X,F6.1,           ••-1
     •2(1X,3(1X,F5.1)),2(1X,2(1X,F5.1)),1X,A1)                          •NEW
      IF(IPTFLG .NE. 0) WRITE(6,970) IHT,IMT,ST,(NEVENT(J),J=1,3),      ••-1
     • ALT,GDLAT,SCLON,ZLVLH,YLVLH,XLVLH,ZIMU,YIMU,XIMU,YAWSUN,
     •PTCSUN,YAWCOE,PTCCOE,IZ,NAMTAR,YAWTAR,PTCTAR                      •NEW
  970 FORMAT(1X,I3,1X,I2,1X,F4.1,1X,3(A6),2(1X,F5.1),1X,F6.1,           ••-1
     •2(1X,3(1X,F5.1)),2(1X,2(1X,F5.1)),1X,A1,1X,A3,2(1X,F5.1))         •NEW
      GO TO 306                                                         ••-1
  305 CONTINUE
      IF(ABS(ZLVLH).LT.0.0495) ZLVLH=.0                                 •NEW
      IF(ABS(YLVLH).LT.0.0495) YLVLH=.0                                 •NEW
      IF(ABS(XLVLH).LT.0.0495) XLVLH=.0                                 •NEW
      IF(ABS(ZIMU).LT.0.0495) ZIMU=.0                                   •NEW
      IF(ABS(YIMU).LT.0.0495) YIMU=.0                                   •NEW
      IF(ABS(XIMU).LT.0.0495) XIMU=.0                                   •NEW
      IF(ZLVLH.GT.359.9495) ZLVLH=.0                                    •NEW
      IF(ZIMU.GT.359.9495) ZIMU=.0                                      •NEW
      IF (IPTFLG .EQ. 0) WRITE (6,960) IHT,IMT,ST,NCARD,NCARD,NCARD,
     •ALT,GDLAT,SCLON,ZLVLH,YLVLH,XLVLH,ZIMU,YIMU,XIMU,YAWSUN,
     •PTCSUN,YAWCOE,PTCCOE,IZ                                           •NEW
      IF (IPTFLG .NE. 0) WRITE (6,970) IHT,IMT,ST,NCARD,NCARD,NCARD,    ••-1
     •ALT,GDLAT,SCLON,ZLVLH,YLVLH,XLVLH,ZIMU,YIMU,XIMU,YAWSUN,
     •PTCSUN,YAWCOE,PTCCOE,IZ,NAMTAR,YAWTAR,PTCTAR                      •NEW
  306 CONTINUE                                                          ••-1
      IF(NUMCOM .EQ. 1) GO TO 350
      DO 320 J=2,NUMCOM
      IJ =(J-1)*3
      WRITE(6,980) NEVENT(IJ+1),NEVENT(IJ+2),NEVENT(IJ+3)
  980 FORMAT(13X,3(A6))
  320 CONTINUE
C
  350 CONTINUE
      GETWRT = IHR + MN/60.0 + SECS/3600.0
C  THE DESCRIPTOR TAPE IS WRITTEN BELOW.
C
      IF(IUWRT .GT. 0) WRITE(IUWRT) GETWRT,ATTSYS,IMUNUM,IVMS,
     • ANG1,ANG2,ANG3,IHOLD,XRATE,YRATE,ZRATE,IPTFLG,ALIGN,INSTID,
     • IANG1,IANG2,ITYPE1,IDEF1,VAR1,VAR2,VAR3,ITARG1,VAR4,IDIN2,
     • IANG12,IANG22,ITYPE2,IDEF2,VAR12,VAR22,VAR32,ITARG2,VAR42,
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01236            • (NEVENT(J),J=1,12),NAMTAR
01236        C
01307            NUMLIN = NUMLIN + NUMCOM
01310            IF (GMTINT .GT. 1.E-4) GO TO 400
01312            IF (IBLANK .NE. 1) CALL CRDFIL(3)
01314            IBLANK = 0
01315            IF(IERR .EQ. 0) GO TO 100
01317            IF(IUWRT .GT. 0) ENDFILE IUWRT
01321            STOP
01322        400 CONTINUE
01323            GMT = GMT + GMTINT/60.0D0
01324            IF (JPCARD .EQ. 0) GO TO 450
01326            CALL CRDFIL(1)
01327            IF (ATTSYS .NE. NBLANK ) CALL CRDFIL(3)
01327        C  THE CALL TO GETDES OBTAINS THE NEXT EVENT SET
01327        C
01331            CALL GETDES(IUREAD,ISTOP)
01331        C
01332            IF (ITAPE .GT. 0 .AND. IERR .LT. 0) RECFLG = - 1.0
01334            IF(RECFLG .LT. 0.)WRITE(ITAPE) RECFLG,PRTFLG,YEAR,GMONTH,GDAY,
01334           •GHR,GMIN,GSEC,GET,(RKMDP(I),I=1,3),(VKMDP(I),I=1,3),(DV(I),I=1,3),
01334           • YIMUDP,ZIMUDP,XIMUDP,RMAGKM,DECGCN,RASGCN,VMAGKM,GAMI,PSII,
01334           • VALTKM,VEHGDL,VEHLON,VELREL,GAMREL,PSIREL,GRAS,REV,AKM,E,RADINC,
01334           • ASCNR,ARGPR,TRUEAN,PERIOD,DYNPR,DRAGKG,LIFTKG,WGTKG,THRKG,ISPSEC,
01334           • EGRAVC,SHADOW,(ATTECI(1,J),J=1,3),(ATTECI(2,J),J=1,3),
01334           • (ATTECI(3,J),J=1,3),YLVLHR,ZLVLHR,XLVLHR,ALSR,BTSR,GMSR,PTSUNR,
01334           • YWSUNR,PTCOER,YWCOER,(RSUNKM(I),I=1,3),(SPARE(I),I=1,14)
01462            IF (RECFLG .LT. 0.)ENDFILE ITAPE
01464            IF (IERR .NE. 0 ) STOP
01466            CALL CRDFIL(1)
01467            JPCARD = 0
01470            TNEXT = IHR + MN/60 + SECS/3600
01471            GMTNXT = TNEXT + BASTIM
01472        450 CONTINUE
01473            IF ( (GMTNXT-GMT) .LE. 1.E-5 ) CALL CRDFIL(1)
01475            IF ( (GMTNXT-GMT) .LE. 1.E-5 ) GO TO 120
01477            ATTSYS = NBLANK
01500            ALIGN = 0
01501            IF (IERR .EQ. 0) GO TO 150
01503            STOP
01504            END

   END OF COMPILATION:        NO  DIAGNOSTICS.
 SAPT           SYMBOLIC          27 JUN 74  15:33:38   0  02621512   14   424  (DELETED)
 SAPT    CODE   RELOCATABLE       27 JUN 74  15:33:38   1  01746122   84     1  (DELETED)
                                                        0  01746246   14   157
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APPENDIX C: RESULTS OF STAR TRACKER CONSTRAINT VIOLATION ANALYSIS FOR SORTIE OPTION 2 OF BRM 2 WITH PLATFORM ALINEMENTS PERFORMED IN THE INERTIAL HOLD MODE AT THE INERTIAL ATTITUDE JUST PRIOR TO THE ALINEMENT *

* Included are printouts for Alpha (α) + 20° for earth pointing constraint violations, printed after each event; and angles Theta (Θ) for Star Tracker 1 and 2 and the Sun, Star Tracker 3 and the Sun, Star Trackers 1 and 2 and the Earth, and Star Tracker 3 and the Earth, printed in a line of four numbers prior to each platform alinement.

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PRELIMINARY BRM MISSION 2 - OPTION 2
SHUTTLE ATTITUDE AND POINTING TIME LINE
WITH STAR TRACKER CONSTRAINTS INDICATED

GET HRS	MN	SECS	EVENT	VEHICLE POSITION ALT N MI	LAT DEG	LON DEG	LVLH ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	ECI ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	LOOK ANGLES TO SUN YAW DEG	PITCH DEG	LOOK ANGLES TO EARTH YAW DEG	PITCH DEG	TARG ID	LOOK ANGLES TO TARGET YAW DEG	PITCH DEG
50	0	.0	MNVR TO INERTIAL HOLD ATT FOR EXP SETUP AND CHECKOUT	233.6	-50.5	93.8	90.0	.0	.0	257.9	34.9	19.8	356.4	345.4	.0	270.0			
89.39802 51	0	.0	TDRS 41W	235.3	44.2	-21.4	89.8	.1	232.0	257.9	34.9	19.8	356.5	345.5	269.9	38.0			
89.39802 51	0	.0	TDRS 171W	235.3	44.2	-21.4	89.8	.1	232.0	257.9	34.9	19.8	356.5	345.5	269.9	38.0			
89.48655 53	0	.0	BEGIN INERTIAL HOLD FOR SLEEP	233.2	-36.5	21.6	90.0	.0	.0	257.3	34.9	43.5	3.2	345.7	.0	270.0			
89.40141 55	0	.0	BEGIN SLEEP PERIOD	235.2	-24.0	122.2	90.2	359.7	103.9	257.3	34.9	43.5	3.3	345.8	89.7	13.9			
89.50570 63	0	.0	END SLEEP PERIOD	232.7	22.2	34.8	89.3	358.6	159.9	257.3	34.9	43.5	3.5	346.0	85.9	69.9			
89.48935 64	24	.0	TDRS 41W	233.1	-6.4	-7.5	90.3	358.2	124.7	257.3	34.9	43.5	3.5	346.1	67.8	34.7			
89.48935 64	24	.0	TDRS 171W	233.1	-6.4	-7.5	90.3	358.2	124.7	257.3	34.9	43.5	3.5	346.1	67.8	34.7			
89.51723 98.94534 64	30	.0	102.96961 27.14784 116.39949 PLATFORM ALINE	232.4	12.7	4.5	89.6	358.3	147.9	257.3	34.9	43.5	3.5	346.1	86.7	57.9	C		
89.32095 64	45	.0	MNVR TO LVLH ATT FOR NV-1 CAL	237.2	52.0	54.2	.0	.0	180.0	335.6	346.7	36.0	268.7	346.5	.0	90.0			
89.60740 65	15	.0	BEGIN INERTIAL HOLD	230.3	-7.8	169.5	-.0	.0	180.0	91.7	54.0	103.6	258.3	6.9	.0	90.0			
89.43381 65	55	.0	MNVR TO LVLH ATT FOR NV-1 CAL	234.4	-12.9	-35.3	.0	.0	180.0	228.9	307.8	[illegible]	[illegible]	358.8	.0	90.0			
89.33717 66	25	.0	BEGIN INERTIAL HOLD	236.8	53.9	73.8	-.0	.0	180.0	350.8	8.6	35.3	263.1	348.4	.0	90.0			
89.48037 67	0	.0	MNVR TO LVLH ATT FOR NV-1 OPS	233.3	-42.6	177.4	.0	.0	180.0	143.6	27.3	139.9	266.6	13.0	.0	90.0			
89.32314 67	50	.0	BEGIN INERTIAL HOLD	237.1	50.1	1.0	-.0	.0	180.0	332.3	343.2	36.7	270.4	346.6	.0	90.0			
89.52163 69	10	.0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS	232.3	15.2	-64.7	.0	.0	180.0	285.1	309.0	65.2	260.7	352.2	.0	90.0			
89.36457 69	35	.0	BEGIN INERTIAL HOLD	236.1	48.0	47.5	.0	-.0	180.0	359.4	20.7	37.7	260.9	350.3	.0	90.0			
89.38317 71	45	.0	MNVR TO LVLH ATT FOR NV-1 AND LO-77A OPS	236.6	-53.5	135.0	.0	-.0	180.0	157.1	9.5	144.6	270.9	13.1	.0	90.0			
89.39530 72	45	.0	BEGIN INERTIAL	235.4	38.9	15.7	-.0	.0	180.0	9.6	32.2	42.5	259.3	352.5	.0	90.0			

ORIGINAL PAGE IS OF POOR QUALITY

		HOLD														
89.50041																
73 38	.0	MNVR TO LVLH ATT FOR NV-1 OPS AND EO-7/8 OPS	232.8	-20.1	-158.4	-.0	.0	180.0	214.9	311.7	120.7	282.8	2.5	.0	90.0	
89.42680																
74 25	.0	BEGIN INERTIAL HOLD	234.6	18.7	10.8	-.0	.0	180.0	37.1	49.2	61.1	257.2	357.8	.0	90.0	
89.32832																
75 0	.0	MNVR TO LVLH ATT FOR NV-1 OPS	237.0	-49.4	141.4	.0	-.0	180.0	176.6	341.5	142.9	277.5	10.6	.0	90.0	
89.37355																
75 32	.0	TDRS 41W	235.9	43.1	-132.0	179.9	56.3	359.9	176.6	341.5	142.9	277.5	10.6	180.0	326.3	
89.37355																
75 32	.0	TDRS 171W	235.9	43.1	-132.0	179.9	56.3	359.9	176.6	341.5	142.9	277.5	10.6	180.0	326.3	
89.30029																
74.40482	19.71246	141.91470	76.84741													
75 38	.0	PLATFORM ALINE	237.7	53.9	-102.1	179.9	33.1	-.0	176.6	341.5	142.9	277.5	10.6	180.0	303.1	D
89.39677																
75 53	.0	BEGIN INERTIAL HOLD	235.3	33.8	-25.6	-.0	.0	180.0	15.1	37.4	46.0	258.9	353.4	.0	90.0	
89.52421																
76 23	.0	MNVR TO LVLH ATT FOR NV-1 OPS	232.3	-1.8	142.7	-.0	-.0	180.0	249.0	304.9	92.8	282.7	358.5	.0	90.0	
89.31220																
76 50	.0	MNVR TO INERTIAL HOLD ATT FOR SLEEP	237.4	53.4	-112.2	90.0	.0	.0	252.4	34.9	167.6	4.6	11.9	.0	270.0	
89.39900																

ORIGINAL PAGE IS
OF POOR QUALITY

SHUTTLE ATTITUDE AND POINTING TIME LINE

GET HRS MN SECS	EVENT	VEHICLE POSITION ALT N MI	LAT DEG	LON DEG	LVLH ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	ECI ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	LOOK ANGLES TO SUN YAW DEG	PITCH DEG	LOOK ANGLES TO EARTH YAW DEG	PITCH DEG	LOOK ANGLES TO TARGET TARG ID	YAW DEG	PITCH DEG
79 0 .0	BEGIN SLEEP PERIOD	235.3	31.3	-70.4	90.0	.0	36.6	252.4	34.9	167.6	4.6	11.9	90.0	308.6			
89.58441																	
87 0 .0	END SLEEP PERIOD	230.8	-14.5	-156.9	90.3	1.2	94.6	252.4	34.9	167.6	4.3	12.0	91.2	4.6			
89.50941																	
86 39 .0	TDRS 41W	232.6	-32.5	-166.1	91.0	1.2	117.4	252.4	34.9	167.6	4.2	12.0	91.3	27.4			
89.50941																	
88 39 .0	TDRS 171W	232.6	-32.5	-166.1	91.0	1.2	117.4	252.4	34.9	167.6	4.2	12.0	91.3	27.4			
89.41213																	
73.01617	103.77608	34.37802	122.56078														
86 45 .0	PLATFORM ALINE	235.0	-47.6	-144.4	91.4	.7	140.6	252.4	34.9	167.6	4.2	12.0	91.1	50.6	C		
89.34898																	
89 0 .0	MNVR TO LVLH ATT FOR NV-1 CAL	236.5	-44.3	-60.3	-.0	.0	180.0	180.2	334.1	140.5	276.5	10.8	.0	90.0			
89.46325																	
89 30 .0	BEGIN INERTIAL HOLD	233.7	44.2	17.1	.0	-.0	180.0	320.9	334.3	39.4	277.1	349.6	.0	90.0			
89.47289																	
90 15 .0	MNVR TO LVLH ATT FOR NV-1 CAL	233.5	-40.4	179.6	.0	.0	180.0	136.4	30.1	138.6	261.8	9.6	.0	90.0			
89.53268																	
90 45 .0	BEGIN INERTIAL HOLD	232.1	-9.6	-51.2	.0	.0	180.0	230.3	306.5	106.2	282.2	3.2	.0	90.0			
89.32501																	
92 0 .0	MNVR TO LVLH ATT FOR NV-1 AND NV-2 EARTH OPS	237.1	-54.4	-139.2	.0	.0	180.0	164.8	353.1	144.8	270.9	12.6	.0	90.0			
89.57644																	
93 5 .0	INERTIAL HOLD	231.0	8.5	94.2	.0	-.0	180.0	52.4	53.9	75.8	257.9	356.6	.0	90.0			
89.53321																	
93 50 .0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS	232.0	-13.3	-100.8	.0	-.0	180.0	222.9	307.9	111.6	281.7	4.8	.0	90.0			
89.40639																	
94 30 .0	BEGIN INERTIAL HOLD	235.1	33.1	51.6	-.0	.0	180.0	12.4	38.0	46.5	261.5	350.6	.0	90.0			
89.52697																	
95 30 .0	MNVR TO LVLH ATT FOR NV-1 OPS	232.2	8.7	-110.6	-.0	.0	180.0	267.7	306.3	74.9	282.6	359.4	.0	90.0			
89.56790																	
96 10 .0	BEGIN INERTIAL HOLD	231.2	12.1	44.6	-.0	.0	180.0	44.8	52.6	70.2	258.3	355.1	.0	90.0			
89.44310																	
96 50 .0	MNVR TO LVLH ATT FOR EO-7/8 OPS	234.2	-31.9	-162.6	.0	.0	180.0	193.5	320.9	132.5	278.4	9.6	.0	90.0			
89.30536																	
97 20 .0	BEGIN INERTIAL HOLD	237.5	52.9	-78.0	.0	-.0	180.0	331.0	348.6	35.7	275.1	348.4	.0	90.0			
89.39484																	
98 20 .0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS AND EO-7/8 OPS	235.4	-40.3	164.1	.0	.0	180.0	183.1	329.3	138.4	276.0	11.3	.0	90.0			
89.34343																	

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98 55	.0	BEGIN INERTIAL HOLD	236.6	54.7	-89.9	-.0	-.0	180.0	335.1	354.9	35.0	273.9	347.8	.0	90.0	
89.51596																
99 30	.0	MNVR TO LVLH ATT FOR NV-1 OPS	232.5	-31.2	27.3	.0	.0	180.0	123.5	39.5	132.2	258.6	5.8	.0	90.0	
89.36811																
99 54	.0	TDRS 41W	236.0	-37.8	143.7	178.6	87.2	358.5	123.5	39.5	132.2	258.6	5.8	180.1	357.2	
89.36811																
99 54	.0	TDRS 171W	236.0	-37.6	143.7	178.6	87.2	356.5	123.5	39.5	132.2	258.6	5.8	180.1	357.2	
89.42457																
79.18516	1.84867	110.98168	71.44991													
100 0	.0	PLATFORM ALINE	234.7	-20.4	159.8	179.9	64.0	359.8	123.5	39.5	132.2	258.6	5.8	180.1	334.0	D
89.50235																
100 15	.0	BEGIN INERTIAL HOLD	232.8	26.7	-168.6	.0	.0	180.0	297.3	316.7	51.8	282.0	355.5	.0	90.0	
89.52514																
101 45	.0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS	232.2	17.4	160.7	.0	.0	180.0	282.6	310.2	62.3	282.7	358.4	.0	90.0	
89.41299																
102 15	.0	MNVR TO INERTIAL HOLD FOR SLEEP	234.9	34.0	-67.4	90.0	.0	.0	248.0	34.9	132.5	7.1	10.8	.0	270.0	
89.36879																
103 0	.0	BEGIN SLEEP PERIOD	236.0	-38.2	96.0	90.1	359.9	174.0	248.0	34.9	132.5	7.0	10.8	89.2	84.0	
89.53301																
111 0	.0	END SLEEP PERIOD	232.1	6.7	11.9	89.8	358.7	230.0	248.0	34.9	132.5	6.8	11.0	271.7	40.0	
89.41853																
112 24	.0	TDRS 41W	234.8	-21.9	-30.3	90.7	358.6	194.7	248.0	34.9	132.5	6.7	11.1	275.5	75.2	
89.41853																
112 24	.0	TDRS 171W	234.8	-21.9	-30.3	90.7	358.6	194.7	248.0	34.9	132.5	6.7	11.1	275.5	75.2	
89.51991																

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SHUTTLE ATTITUDE AND POINTING TIME LINE

GET		VEHICLE POSITION			LVLH ATTITUDE			ECI ATTITUDE			LOOK ANGLES TO SUN		LOOK ANGLES TO EARTH		LOOK ANGLES TO TARGET		
		ALT	LAT	LON	YAW	PITCH	ROLL	YAW	PITCH	ROLL	YAW	PITCH	YAW	PITCH	TARG	YAW	PITCH
HRS MN SECS	EVENT	N MI	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	ID	DEG	DEG
73.93813	106.29785 32.98704 49.06826																
112 30 .0	PLATFORM ALINE	232.4	-3.1	-17.7	90.1	358.4	218.0	246.0	34.9	132.5	6.7	11.1	272.6	52.0 E			
89.33221																	
113 45 .0	MNVR TO LVLH ATT FOR NV-1 CAL	236.9	-52.0	-97.4	.0	.0	180.0	165.5	346.4	144.0	268.0	13.4	.0	90.0			
89.47314																	
114 15 .0	BEGIN INERTIAL HOLD	233.5	33.8	-14.6	.0	.0	180.0	304.0	322.9	45.8	283.0	356.0	.0	90.0			
89.54086																	
114 45 .0	MNVR TO LVLH ATT FOR NV-1 CAL	231.9	17.6	117.4	-.0	-.0	180.0	31.3	49.9	62.5	260.7	350.0	.0	90.0			
89.32237																	
115 15 .0	BEGIN INERTIAL HOLD	237.1	-55.0	-139.5	.0	-.0	180.0	158.3	356.1	145.0	264.9	12.7	.0	90.0			
89.52450																	
115 35 .0	MNVR TO LVLH ATT FOR NV-1 OPS	232.3	-6.6	-67.2	.0	-.0	180.0	231.9	305.6	101.1	281.3	7.7	.0	90.0			
89.43507																	
116 40 .0	BEGIN INERTIAL HOLD	234.4	-47.3	149.8	.0	.0	180.0	139.4	21.4	142.1	258.8	8.1	.0	90.0			
89.55260																	
118 45 .0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS AND EO-7/8 OPS	231.6	5.7	-106.8	-.0	.0	180.0	257.3	305.5	79.8	283.0	5.2	.0	90.0			
89.46132																	
119 25 .0	BEGIN INERTIAL HOLD	233.8	15.0	48.3	-.0	-.0	180.0	34.9	51.3	65.9	260.5	349.6	.0	90.0			
89.55415																	
120 15 .0	MNVR TO LVLH ATT FOR NV-1 OPS AND NV-2 OPS	231.5	-4.1	-136.5	-.0	-.0	180.0	236.4	305.1	96.7	281.6	8.1	.0	90.0			
89.55463																	
121 0 .0	BEGIN INERTIAL HOLD	231.5	8.9	28.7	.0	-.0	180.0	46.2	53.8	75.1	259.3	350.6	.0	90.0			
89.52998																	
121 45 .0	MNVR TO LVLH ATT FOR EO-7/8 OPS	232.1	-13.8	-166.3	.0	-.0	180.0	216.8	308.1	112.2	279.6	10.6	.0	90.0			
89.31809																	
122 12 .0	BEGIN INERTIAL HOLD	237.2	55.2	-77.4	.0	-.0	180.0	333.0	358.3	34.9	278.1	348.2	.0	90.0			
89.43719																	
122 50 .0	MNVR TO LVLH ATT FOR NV-1 OPS	234.4	-42.1	46.0	-.0	.0	180.0	132.2	28.2	139.6	256.7	5.4	.0	90.0			
89.29574																	
123 45 .0	BEGIN INERTIAL HOLD	237.8	55.1	-101.4	.0	-.0	180.0	332.6	358.1	34.9	278.5	348.3	.0	90.0			
89.36388																	
124 39 .0	TDRS 41W	236.4	-47.5	110.2	180.2	331.2	359.9	332.6	358.1	34.9	278.6	348.3	359.9	298.8			
89.36388																	
124 39 .0	TDRS 171W	236.4	-47.5	110.2	180.2	331.2	359.9	332.6	358.1	34.9	278.6	348.3	359.9	298.8			
89.42774																	

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   96.70908   21.17232  122.98055   96.65373
124 45   .0 PLATFORM ALINE      234.6 -32.3  131.8   180.3 308.0 359.8  332.6 358.1   34.9  278.6 348.3  359.8 322.0 D
  89.52720
125  0   .0 MNVR TO LVLH ATT    232.2  14.4  164.3     -.0    .0 180.0  273.0 308.6  64.3  284.0   4.1      .0  90.0
            FOR NV-1 OPS AND
            NV-2 EARTH OPS
  89.41005
125 30   .0 MNVR TO INERTIAL    235.0  36.6  -64.7    90.0    .0   -.0  243.6  34.8 136.2    2.4  14.4      .0 270.0
            ATT FOR SLEEP
  89.37492
127  0   .0 BEGIN SLEEP PERIOD  235.9  44.4  -99.3    89.8    .1 348.0  243.6  34.8 136.2    2.3  14.5  209.4 282.0
  89.57663
135  0   .0 END SLEEP PERIOD    231.0   1.2 -179.1    89.9   1.5  44.0  243.6  34.8 136.2    2.0  14.7   92.1 314.0
  89.39850
136 24   .0 TDRS 41W            235.3  29.4  137.4    89.0   1.3   8.7  243.6  34.8 136.2    2.0  14.7   98.8 278.8
  89.39850
136 24   .0 TDRS 171W           235.3  29.4  137.4    89.0   1.3   8.7  243.6  34.8 136.2    2.0  14.7   98.8 278.8
  89.53533
   70.30528  101.40363  143.00717  115.23089
136 30   .0 PLATFORM ALINE      232.0  10.9  151.2    89.6   1.6  32.0  243.6  34.8 136.2    2.0  14.7   93.1 302.0
  89.49382
136 45   .0 MNVR TO LVLH ATT    233.0 -35.4 -175.3      .0    .0 180.0  121.7  35.5 135.4  254.1    .7      .0  90.0
            FOR NV-1 CAL
  89.29719
137 45   .0 BEGIN INERTIAL      237.7  54.6   61.7     -.0   -.0 180.0  335.3   5.8  35.1  279.6 347.1      .0  90.0
            HOLD
  89.35832
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ORIGINAL PAGE IS
OF POOR QUALITY

SHUTTLE ATTITUDE AND POINTING TIME LINE

GET HRS	GET MN	GET SECS	EVENT	VEHICLE POSITION ALT N MI	VEHICLE POSITION LAT DEG	VEHICLE POSITION LON DEG	LVLH ATTITUDE YAW DEG	LVLH ATTITUDE PITCH DEG	LVLH ATTITUDE ROLL DEG	ECI ATTITUDE YAW DEG	ECI ATTITUDE PITCH DEG	ECI ATTITUDE ROLL DEG	LOOK ANGLES TO SUN YAW DEG	LOOK ANGLES TO SUN PITCH DEG	LOOK ANGLES TO EARTH YAW DEG	LOOK ANGLES TO EARTH PITCH DEG	LOOK ANGLES TO TARGET TARG ID	LOOK ANGLES TO TARGET YAW DEG	LOOK ANGLES TO TARGET PITCH DEG
139	12	.0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS	236.3	51.9	.2	.0	.0	180.0	321.5	346.6	36.0	284.2	352.0	.0	90.0			
89.58815																			
139	40	.0	BEGIN INERTIAL HOLD	230.7	-1.4	111.6	-.0	.0	180.0	64.3	55.1	92.8	257.8	349.1	.0	90.0			
89.35613																			
140	10	.0	MNVR TO LVLH ATT FOR NV-1 OPS	236.3	-46.7	-124.4	-.0	.0	180.0	167.7	337.3	141.8	265.2	15.7	.0	90.0			
89.49162																			
140	36	.0	BEGIN INERTIAL HOLD	233.0	30.7	-59.2	.0	-.0	180.0	295.1	320.1	48.1	286.3	1.8	.0	90.0			
89.38033																			
141	48	.0	MNVR TO LVLH ATT FOR NV-1 OPS AND ED-7/8 OPS	235.7	-34.3	-130.1	-.0	.0	180.0	182.0	323.1	134.4	270.4	16.6	.0	90.0			
89.49988																			
142	38	.0	BEGIN INERTIAL HOLD	232.8	24.1	47.3	.0	.0	180.0	15.6	45.6	54.7	265.7	343.8	.0	90.0			
89.50961																			
143	40	.0	MNVR TO LVLH ATT FOR NV-2 EARTH OPS	232.6	24.4	-111.9	.0	.0	180.0	285.9	314.9	54.0	286.2	4.7	.0	90.0			
89.40041																			
144	6	.0	BEGIN INERTIAL HOLD	235.2	38.6	9.4	.0	-.0	180.0	356.4	32.5	42.6	271.9	343.2	.0	90.0			
89.46377																			
145	0	.0	MNVR TO LVLH ATT FOR NV-1 OPS AND ED-7/8 OPS	233.7	-16.7	-162.6	-.0	.0	180.0	207.1	309.6	114.4	276.6	15.7	.0	90.0			
89.36439																			
145	25	.0	BEGIN INERTIAL HOLD	236.1	52.9	-90.0	-.0	-.0	180.0	322.0	348.9	35.6	285.1	351.9	.0	90.0			
89.49424																			
146	6	.0	MNVR TO LVLH ATT FOR NV-1 OPS AND ED-7/8 OPS	233.0	-42.3	51.9	.0	-.0	180.0	128.0	28.0	139.7	253.0	2.1	.0	90.0			
89.32298																			
147	6	.0	BEGIN INERTIAL HOLD	237.1	51.8	-64.5	-.0	-.0	180.0	339.5	14.0	36.1	279.2	345.3	.0	90.0			
89.33117																			
147	51	.0	TDRS 41W	236.9	-53.7	94.9	180.1	6.0	-.0	339.5	14.0	36.1	279.3	345.3	180.2	276.0			
89.33117																			
147	51	.0	TDRS 171W	236.9	-53.7	94.9	180.1	6.0	-.0	339.5	14.0	36.1	279.3	345.3	180.2	276.0			
89.37751																			
99.72243			23.16065 157.78198	89.32535															
147	57	.0	PLATFORM ALINE	235.8	-42.6	124.4	180.1	342.8	359.9	339.5	14.0	36.1	279.3	345.3	359.8	267.2	D		
89.54282																			
148	12	.0	MNVR TO LVLH ATT FOR NV-1 OPS AND ED-7/8 OPS	231.8	1.9	162.0	.0	.0	180.0	243.7	304.9	86.4	282.2	12.6	.0	90.0			
89.38776																			
148	45	.0	MNVR TO INERTIAL	235.5	39.1	-62.1	90.0	-.0	.0	239.2	34.8	139.8	357.0	17.3	.0	270.0			

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ATT FOR SLEEP

89.35034																
151 0	.0	BEGIN SLEEP PERIOD	236.4	-49.5	63.5	90.3	359.9	162.0	239.2	34.8	139.8	356.9	17.4	89.5	72.0	
89.51653																
159 0	.0	END SLEEP PERIOD	232.4	-9.0	-10.2	90.3	358.5	216.0	239.2	34.8	139.8	356.6	17.5	272.5	52.0	
87.35608																
160 9	.0	TDRS 41W	236.3	-52.8	-135.0	91.7	.4	124.7	239.2	34.8	139.8	356.6	17.5	90.5	34.7	
89.35608																
160 9	.0	TDRS 171W	236.3	-52.8	-135.0	91.7	.4	124.7	239.2	34.8	139.8	356.6	17.5	90.5	34.7	
89.33117																
67.47160	96.03570	27.06258	115.92986													
160 15	.0	PLATFORM ALINE	236.9	-54.2	-97.2	91.8	359.7	147.9	239.2	34.8	139.8	356.6	17.5	89.5	57.9	C
87.54342																
161 30	.0	START PAYLOAD CLOSEOUT	231.8	-23.8	155.9	90.9	1.7	78.0	239.2	34.8	139.8	356.5	17.5	91.8	348.0	

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APPENDIX D: RESULTS OF STAR TRACKER CONSTRAINT VIOLATIONS ANALYSIS FOR PRELIMINARY BASELINE REFERENCE MISSION 1 USING PLATFORM ALINEMENTS IN THE INERTIAL HOLD MODE AT AN INITIAL LVLH ATTITUDE OF 0, 0, 0 *

* Included are printouts of Alpha (α) + 20° for Earth pointing constraint violations, printed after each event; and Angles Theta (Θ) for Star Trackers 1 and 2 and the Sun, Star Tracker 3 and the Sun, Star Trackers 1 and 2 and the Earth, and Star Tracker 3 and the Earth, printed in a set of four numbers prior to each Platform Alinement.

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PRELIMINARY BASELINE REFERENCE MISSION 1
SHUTTLE ATTITUDE AND POINTING TIME LINE
WITH STAR TRACKER CONSTRAINTS INDICATED

GET HRS MN SECS	EVENT	VEHICLE POSITION ALT N MI	LAT DEG	LON DEG	LVLH ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	ECI ATTITUDE YAW DEG	PITCH DEG	ROLL DEG	LOOK ANGLES TO SUN YAW DEG	PITCH DEG	LOOK ANGLES TO EARTH YAW DEG	PITCH DEG	TARG ID	LOOK ANGLES TO TARGET YAW DEG	PITCH DEG
0 45 55.5	MNVR TO ATT FOR ORB INSERTION	152.8	-29.4	74.2	359.8	13.1	.0	248.3	6.0	298.4	194.3	352.7	180.0	283.1			
93.23810																	
1 30 .0	BEGIN ON-ORBIT OPERATIONS	152.8	29.3	-121.2	180.1	350.7	180.0	248.3	6.0	298.4	194.3	352.8	360.0	80.7			
93.23769																	
3 0 .0	BEGIN SLEEP PERIOD	152.8	29.3	-143.9	179.9	350.8	180.0	248.3	6.0	298.4	194.4	352.8	.0	80.8			
93.23775																	
10 30 .0	END SLEEP PERIOD	152.8	29.3	102.5	178.7	351.5	179.9	248.3	6.0	298.4	194.6	353.1	.4	81.5			
93.28035																	
11 24 .0	TDRS 41W	152.0	-23.9	-51.2	.0	.0	.0	287.3	344.0	294.5	204.6	311.0	.0	270.0		311.8	59.7
93.28035																	
11 24 .0	TDRS 171W	152.0	-23.9	-51.2	.0	.0	.0	287.3	344.0	294.5	204.6	311.0	.0	270.0		184.6	325.5
93.33013																	
158.73898 71.00446 180.00000 90.00000																	
11 30 .0	PLATFORM ALINE	151.1	-14.9	-29.1	.0	-.0	.0	311.3	335.5	286.1	228.8	291.3	.0	270.0	B		
93.23809																	
12 0 .0	INITIATE TUG DEPLOYMENT	152.8	29.3	79.7	-.0	-.0	.0	74.9	359.4	241.0	343.5	15.0	.0	270.0			
93.28902																	
12 11 9.0	TUG SEPARATION	151.9	21.0	125.6	-.0	-.0	-.0	115.5	19.4	248.0	330.1	56.5	.0	270.0			
93.25559																	
12 40 .0	INITIATE LOS ATT	152.5	-27.2	-132.9	.0	.0	.0	237.1	10.1	297.3	196.1	4.3	.0	270.0			
93.23849																	
27 0 .0	BEGIN SLEEP PERIOD	152.8	29.3	-147.5	177.8	341.3	180.0	237.1	10.1	297.3	196.4	4.8	.1	71.3			
93.30793																	
35 0 .0	END SLEEP PERIOD	151.5	-15.4	-152.5	4.3	318.1	356.0	237.1	10.1	297.3	196.6	5.0	355.6	312.1			
93.30695																	
36 54 .0	TDRS 41W	151.5	-22.4	-78.0	.0	-.0	.0	283.7	342.1	293.3	209.2	315.1	.0	270.0		352.7	40.8
93.30695																	
36 54 .0	TDRS 171W	151.5	-22.4	-78.0	.0	-.0	.0	283.7	342.1	293.3	209.2	315.1	.0	270.0		198.3	348.3
93.36311																	
153.63131 66.01779 180.00000 90.00000																	
37 0 .0	PLATFORM ALINE	150.5	-12.8	-56.4	.0	-.0	.0	308.2	334.3	284.0	231.2	296.4	.0	270.0	B		
93.31887																	
48 54 .0	TDRS 41W	151.3	-21.6	100.0	.0	-.0	.0	282.1	341.3	292.6	211.3	317.1	.0	270.0		175.9	308.1
93.31887																	
48 54 .0	TDRS 171W	151.3	-21.6	100.0	.0	-.0	.0	282.1	341.3	292.6	211.3	317.1	.0	270.0		19.9	351.9
93.37779																	
151.20333 63.63648 180.00000 90.00000																	
49 0 .0	PLATFORM ALINE	15[illegible].2	-11.8	121.4	.0	-.0	.0	306.8	333.8	283.0	232.2	298.8	.0	270.0	B		
93.24220																	
51 0 .0	BEGIN SLEEP PERIOD	152.7	29.2	-150.9	179.8	60.2	180.1	306.8	333.8	283.0	232.2	298.9	180.1	29.8			
93.28259																	
59 0 .0	END SLEEP PERIOD	152.0	-17.2	-156.8	178.9	300.[illegible]	182.4	306.8	333.8	283.0	232.1	299.2	358.6	30.9			
93.33046																	
60 54 .0	TDRS 41W	151.1	-20.9	-82.0	-.0	.0	.0	280.5	340.4	291.9	213.2	319.1	.0	270.0		358.9	37.7
93.33046																	
60 54 .0	TDRS 171W	151.1	-20.9	-82.0	-.0	.0	.0	280.5	340.4	291.9	213.2	319.1	.0	270.0		201.4	352.0
93.39191																	
148.76187 61.24009 180.00000 90.00000																	

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61	0	.0	PLATFORM ALINE	149.9	-10.8	-60.8	.0	-.0	.0	305.5	333.3	281.9	233.1	301.2	.0	270.0	B		
93.34169																			
72	54	.0	TDRS 41W	150.9	-20.0	95.9	.0	.0	.0	279.0	339.6	291.1	215.1	321.2	.0	270.0		181.8	310.7
93.34169																			
72	54	.0	TDRS 171W	150.9	-20.0	95.9	.0	.0	.0	279.0	339.6	291.1	215.1	321.2	.0	270.0		22.9	348.2
93.40545																			
146.30842	58.83363	180.00000	90.00000																
73	0	.0	PLATFORM ALINE	149.7	-9.8	117.0	.0	-.0	-.0	304.2	332.8	280.8	233.9	303.7	.0	270.0	B		
93.24853																			
75	0	.0	BEGIN SLEEP PERIOD	152.6	28.8	-154.3	179.9	60.1	180.2	304.2	332.8	280.8	233.9	303.8	180.1	29.9			
93.25729																			
83	0	.0	END SLEEP PERIOD	152.5	-19.0	-160.9	179.1	300.8	182.2	304.2	332.8	280.8	233.8	304.1	358.7	30.8			
93.35256																			
84	54	.0	TDRS 41W	150.7	-19.2	-86.1	-.0	-.0	.0	277.5	338.7	290.3	216.9	323.2	.0	270.0		4.5	34.4
93.35256																			
84	54	.0	TDRS 171W	150.7	-19.2	-86.1	-.0	-.0	.0	277.5	338.7	290.3	216.9	323.2	.0	270.0		204.2	355.7
93.41835																			
143.84460	56.42236	180.00000	90.00000																
85	0	.0	PLATFORM ALINE	149.4	-8.7	-65.2	-.0	.0	-.0	303.0	332.4	279.6	234.6	306.2	.0	270.0	B		
93.36303																			
96	54	.0	TDRS 41W	150.5	-18.3	91.9	.0	.0	.0	276.1	338.0	289.4	218.6	325.3	.0	270.0		187.1	313.5
93.36303																			
96	54	.0	TDRS 171W	150.5	-18.3	91.9	.0	.0	.0	276.1	338.0	289.4	218.6	325.3	.0	270.0		25.5	344.5
93.43058																			
141.37226	54.01178	180.00000	90.00000																
97	0	.0	PLATFORM ALINE	149.2	-7.6	112.6	.0	-.0	-.0	301.8	332.1	278.4	235.3	308.6	.0	270.0	B		
93.24094																			
98	0	.0	BEGIN SLEEP PERIOD	152.8	-20.1	-28.4	180.0	300.1	180.2	301.8	332.1	278.4	235.3	308.7	359.9	30.1			
93.43926																			
106	0	.0	END SLEEP PERIOD	149.0	-6.8	-24.1	.3	359.3	1.3	301.8	332.1	278.4	235.2	309.0	61.0	271.5			
93.37311																			
108	54	.0	TDRS 41W	150.3	-17.4	-90.1	.0	.0	.0	274.7	337.2	288.5	220.2	327.4	.0	270.0		9.6	30.9
93.37311																			
108	54	.0	TDRS 171W	150.3	-17.4	-90.1	.0	.0	.0	274.7	337.2	288.5	220.2	327.4	.0	270.0		206.7	359.6
93.44211																			
138.89338	51.60782	180.00000	90.00000																
109	0	.0	PLATFORM ALINE	149.0	-6.5	-69.6	-.0	-.0	-.0	300.7	331.7	277.2	235.8	311.1	.0	270.0	B		
93.38276																			
120	54	.0	TDRS 41W	150.1	-16.4	87.8	-.0	.0	-.0	273.3	336.5	287.6	221.7	329.6	.0	270.0		191.9	316.4
93.38276																			
120	54	.0	TDRS 171W	150.1	-16.4	87.8	-.0	.0	-.0	273.3	336.5	287.6	221.7	329.6	.0	270.0		27.8	340.7
93.45289																			
136.41014	49.21693	180.00000	90.00000																
121	0	.0	PLATFORM ALINE	148.8	-5.4	108.2	.0	-.0	.0	299.5	331.5	275.9	236.3	313.6	.0	270.0	B		
93.21700																			
122	0	.0	BEGIN SLEEP PERIOD	153.2	-21.8	-32.2	180.0	300.1	180.1	299.5	331.5	275.9	236.3	313.6	359.9	30.1			
93.46051																			
130	0	.0	END SLEEP PERIOD	148.6	-4.6	-28.5	.2	359.3	1.3	299.5	331.5	275.9	236.2	313.9	62.5	271.5			
93.39197																			
132	54	.0	TDRS 41W	149.9	-15.4	-94.2	.0	.0	.0	272.0	335.8	286.6	223.1	331.8	.0	270.0		14.0	27.2
93.39197																			
132	54	.0	TDRS 171W	149.9	-15.4	-94.2	.0	.0	.0	272.0	335.8	286.6	223.1	331.8	.0	270.0		208.7	3.6
93.46289																			